TECHNICAL PROGRESS REPORT #4

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Mercury Specie and Multi-Pollutant Control

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Disclaimer

Acknowledgment

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Abstract

This report is the fourth quarterly Technical Progress Report submitted by Pegasus Technologies, Inc., under Award Identification Number, DE-FC26-06NT42389 for the effort entitled “Mercury Specie and Multi-Pollutant Control.

This report is the fourth of the required reports listed in Attachment B Federal Assistance Reporting Checklist, part of the Cooperative Agreement. This report covers the award period from January 1, 2007 to March 31, 2007 and the efforts within the first budget period which include among other items the installation of advanced sensors and optimization systems, capture of as found baseline data, and beginning and completion of parametric testing during that period.

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1 Introduction

This project was awarded to demonstrate the ability to affect and optimize mercury speciation and multi-pollutant control using non-intrusive advanced sensor and optimization technologies. The intent is to demonstrate plant wide optimization systems on a large coal fired steam electric power plant in order to minimize emissions specifically including mercury while maximizing the efficiency, and maintaining saleable byproducts of the plant as an electricity producer. Advanced solutions utilizing state of the art sensors and neural network based optimization and control technologies will be used to maximize the portion of the mercury vapor in the boiler flue gas which is oxidized or captured in particle bonds resulting in lower uncontrolled releases of mercury.

Budget period 1 is defined in the scope as the design period. The formal scope deliverables for budget period 1 include the installation of all sensors, design of software system, and establishment of the as-found baseline, conducting parametric testing and producing operating and test metrics for pre-project and post-project data comparison, as well as the required project management steps including the budget period 1 review meeting.

This report covers the fourth quarter of the project. This period was focused on initial activities related to installation of key sensors and the communications to them. Also during this past quarter many of the initial engineering on the Optimizers including functional specifications, MV lists, I/O lists were begun or submitted to the site for review.

Pegasus/NeuCo is shouldering 61% of the total project cost; while DOE is providing the remaining 39%. The DOE requires repayment of its investment. This repayment will result from commercial sales of the products developed under the project. NRG Texas (formerly Texas Genco) is contributing the host site, human resources, and engineering support to ensure the project's success.

2 Executive Summary

Pegasus/NeuCo has worked on the project during this fourth reporting period and as such is proceeding along the schedule path however at a slower pace than originally proposed. This is principally due to two issues. One being a deviation from original plan due to a business transaction and resulting typical transition of personnel which can occur in such transactions. The second and the principal single effect on critical path is that an outage is required for final installation of the Zolo equipment. This is not in small part due to the late start during the primary outage which was already in process prior to the CA authorization. The Zolo equipment is now physically installed and is beginning the process of being calibrated. This delay which required an unit outage has resulted in a net 5 month delay of BP1, for which we have submitted a "no cost extension". The project scope of work entails the installation and demonstration of sensors and optimization software in 6 technology packages as well as the required Project Management tasks. Many of the sensors and optimizer technology that will be installed are utilized across the modules; therefore, they have been included under the module in which they are most used. The technology packages as defined in the CA for this project include:

2.1 Intelligent Fuel Management System (FMS)

The FMS is composed of the Combustion Optimization System, the Ready Engineering Coal Fusion System, and SABIA's elemental analyzer.

Pegasus/NeuCo project management has worked with and directed the sub-vendors of this task. The Sabia elemental analyzer has now finished calibration and is producing reasonable analyses. Many of the calibration steps included work performed by the Limestone site personnel including the gathering of controlled coal samples.

Pegasus/NeuCo has completed the selection, issuance of purchase orders, and initiated work with the subvendor for the outside evaluation, analysis, and reporting of coal and ash samples. This vendor was first used for the Sabia calibration reference. This also begins the initial data for baseline accumulation of data.

Ready Engineering has shipped equipment to site. Limestone has reviewed all the HMI programming outline and has finished programming the HMI interface for the Ready equipment. Final configuration is expected to be completed early in the next quarter.

2.2 Mercury Specie Control System:

The Mercury Specie Control System includes the boiler area optimization, sensors from ZOLO, PS Analytical, and Triple 5. Mercury emissions will be measured through Continuous Emission Monitors (CEMs) by PS Analytical.

Zolo requires the port rodder option to be installed on the opposite wall in addition to the existing side that are already installed. This work was done during the planned outage in March 2007. This has introduced a significant delay for this part of the project and to the start of other work. This delay which required an unit outage has resulted in a net 5 month delay of BP1, for which we have submitted a "no cost extension".

The Triple 5 coal flow sensors are installed and showing interesting signals.

PSA mercury analyzers are now physically installed with new probe heaters. The probe/heater assemblies were shipped back to PSA for modification. All four analyzers are operating, but the results are not yet validated because of problems with the span measurement. This issue is expected to be resolved early in the next quarter.

2.3 Advanced Electrostatic Precipitator (ESP) Optimization

Advanced Electrostatic Precipitator (ESP) Optimization System: The ESP Optimization System is composed of a Carbon-In-Ash (CIA) virtual online analyzer, a CIA sensor from ABB, and ESP Optimization software.

The ABB Carbon-In-Ash (CIA) zero (no load) calibration was done and several rounds of samples were sent for analysis. Calibration is now complete with the exception of two ash volume probes (stretch goal).

Pegasus/NeuCo has worked with Solvera (stock equipment) to order, manufacture, and install an MIU (communications device) for the exchange of data in and out of the TR set voltage controllers of the ESP. This will enhance baseline and testing data as needed for the ESP. Output data back to the AVC TR sets is being worked on by our personnel.

2.4 System Advanced Intelligent Soot Blowing (ISB) System:

Advanced Intelligent Soot Blowing (ISB) System: The ISB system is composed of Pegasus' Intelligent Sootblowing software. Note that this module was previously demonstrated, and does not constitute new demonstration technology although certain advances are likely.

Limestone and Pegasus/NeuCo worked to understand the Limestone sootblowing equipment and interface requirements. The I/O list and interface has been completed and the programming interface discussed with site. Input data is now being collected from the sootblower OPC server.

2.5 Advanced Flue Gas Desulfurization (FGD) Optimization System:

Advanced Flue Gas Desulfurization Optimization System: The FGD Optimization System is composed of Pegasus' FGD Optimization software.

The Functional Specification for the FGD was updated to reflect DBA price increases. Limestone has elected to continue using DBA instead of the proposed replacement chemical.

2.6 Intelligent Optimization:

Intelligent Plant (Unit Optimization): The Pegasus i-Plant Optimization System will arbitrate among the solutions for the above systems.

Architecture for the overall systems design including communications architecture, DCS point access, and all advanced sensor inputs was designed and implementation continued to be worked on during this period. A list of 922 points was developed for collection of baseline data. All points are showing the same status as the DCS points.

2.7 Project management required activities

Project management required activities were completed during the period.

3 Discussion

3.1 Discussion Overview

During this fourth reporting period from January 1, 2007 through March 31, 2007, the major effort has been the installation and communications to the advanced sensors. Reasonable progress to that effort has been achieved. Below is a discussion organized by package that corresponds to those listed in the CA. Figure 1 shows the architecture of the packages as mapped to over the site schematic.

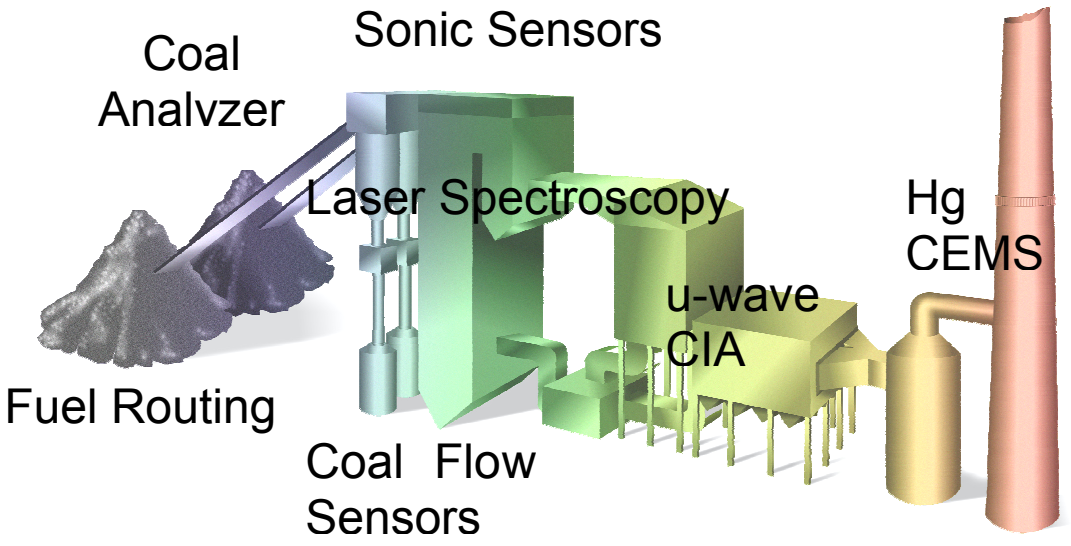

Figure 1 Advanced Sensors being added

3.2 Discussion by Package

The Application engineers continued working with site personnel to exchange specific detailed information about each area of the plant for data capture.

3.2.1 Intelligent Fuel Management System (FMS):

The FMS system consists primarily of the area from the fuel pile to the entrance to the mills. The FMS primary subvendors are Sabia Inc. and Ready Engineering.

a. Goals for the past quarter were:
    i. Confirm calibration of elemental coal analyzer
    ii. Review Ready Engineering Coal Fusion design
    iii. Install Ready Engineering CoalFusion.
b. Accomplishments for the past quarter were:

i. Sabia coal analyzer calibration is complete, and run in time only schedule item remaining.
ii. Ready Engineering Coal Fusion design is complete and the control computer is at site ready to start installation early next quarter.
iii. Re.- Ready; Rotary plough position indicators will be installed early in the next quarter.
iv. Re.- Ready; Limestone has finished programming the display HMI screens and PLC interface for Coal Fusion.

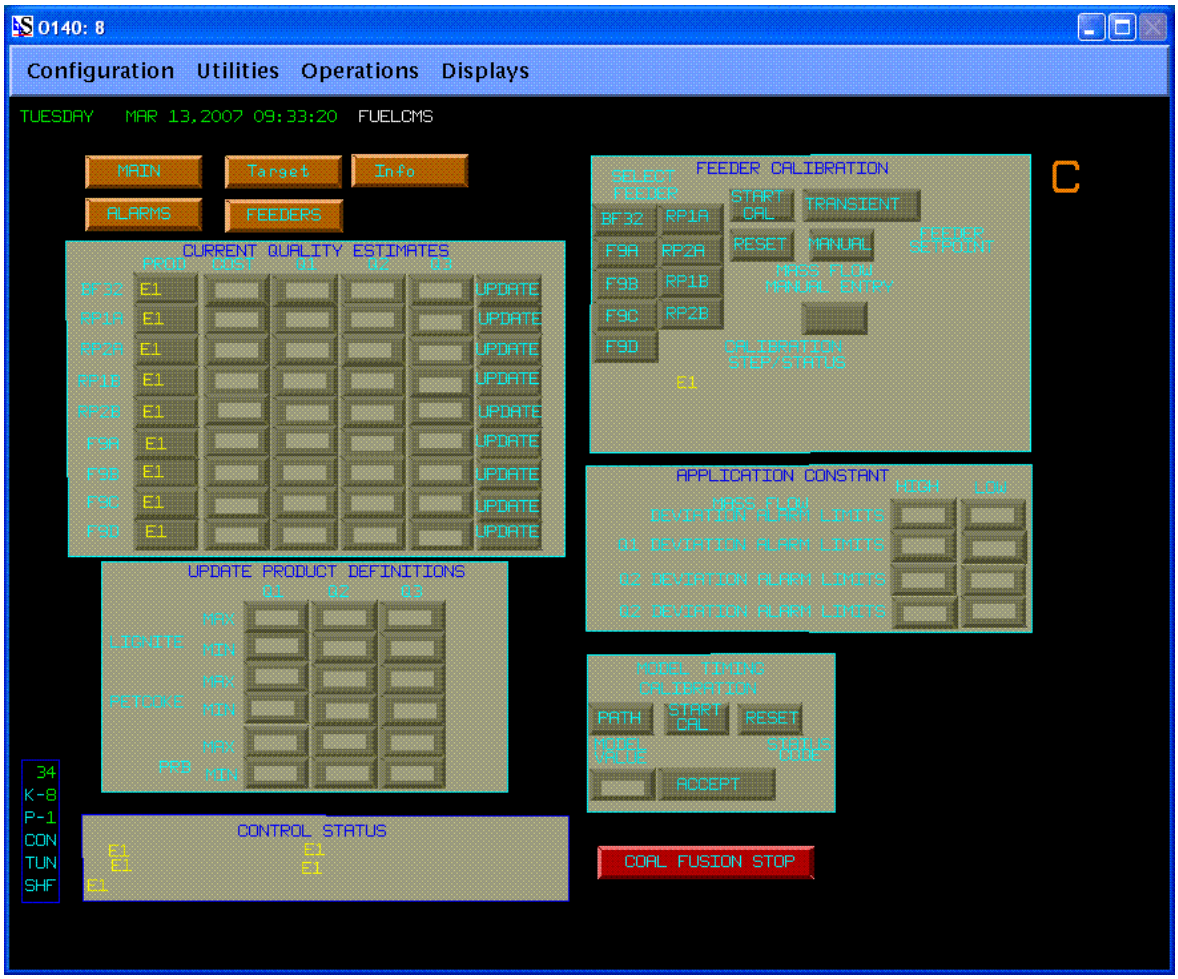

Figure 2 Sabia HMI Screen Example

3.2.2 Mercury Specie Control System:

The Mercury Specie Control System includes Pegasus' Virtual Online Analyzers (VOAs); sensors from ZOLO, PS Analytical, and Triple 5; Mercury emissions will be measured through Continuous Emission Monitors (CEMs) by PS Analytical

a. Goals for the past quarter were:

i. Limestone staff to configure and install the DCS logic changes for the site.
ii. Install PSA Hg CEMS equipment and begin site training and calibration.
iii. Complete the laser spectroscopy installation and begin verification.
iv. Remotely verify calibration of the slag sensors.

b. Accomplishments for the past quarter were:
i. DCS logic configuration is complete at the end of the quarter.
ii. Hg CEMS are physicaly installed and operating with new probe heaters at the end of the quarter These are in process of having their span calibrations completed correctly. Reliability and run in time are very important also.
iii. The Laser spectroscopy equipment is fully on site and all base elements have been installed and operable. The unit had slag on the walls which necessitated the ordering and the installation of "port rodders" on both sides of the unit. These are now installed during the outage and operational. This allows the calibration and check out of the system to begin. This process will continue during the quarter and remains the critical path.
iv. The slag sensors using the new sensor choice have been connected and are ahead of the original intended technological selection's schedule. The slag sensors have now been verified.

3.2.3 Advanced Electrostatic Precipitator (ESP)

The Advanced Electrostatic Precipitator (ESP) Optimization System is composed of a Carbon-In-Ash (CIA) virtual online analyzer, a CIA sensor from ABB, and Pegasus's ESP Optimization software.

a. Goals for the past quarter were:
i. Calibrate the ABB CIA monitors
ii. Complete the communication links needed to gather CIA data online.

b. Accomplishments for the past quarter were:

i. The ABB Carbon-In-Ash (CIA) zero (no load) calibration was done and several rounds of samples were sent for analysis. Calibration is finished, except that ash loading still needs to be verified.
ii. Limestone personnel were able to finish the communication link.
iii. The Functional Specification for the ESP was completed and set to site for review and comment.

3.2.4 Advanced Intelligent Soot Blowing (ISB)

The Advanced Intelligent Soot Blowing (ISB) System is composed of Pegasus' Intelligent Sootblowing software. Note that this module was previously demonstrated, and does not constitute demonstration technology.

a. Goals for the past quarter were:
i. Prepare the Functional Specification for the ISB.
ii. Prepare a test plan for the ISB.

iii. Collect data from soot blower system.

b. Accomplishments for the past quarter were:
   i. The functional specification for the ISB was not completed due to limitation of personnel while working other facets of the project.
   ii. The test plan for the ISB was not completed due to limitation of personnel while working other facets of the project.
   iii. The data collection is now active for the soot blower system and alternative sensors.

3.2.5 Advanced Flue Gas Desulfurization Optimization System (FGD

The Advanced Flue Gas Desulfurization Optimization System (FGD) Optimization System is composed of Pegasus' FGD Optimization software. .

a. Goals for the past quarter were:
   i. Draft, review and issue the functional specification.
   ii. Issue and review with site the test plan
   iii. Issue the suggested DCS changes.
   iv. Issue the display changes
b. Accomplishments for the past quarter were:
   i. The functional specification was issued to the site for review.
   ii. The test plan was not drafted pending discussion with the site on the functional specification. It is intended to use automated testing. The site started testing a replacement chemical that is less expensive than DBA. This test was complete by mid-February, but the site chose to continue using DBA.
   iii. The suggested DCS changes were completed.
   iv. The display changes are in part predicated on the completion of the functional specification.

3.2.6 Intelligent Optimization

The Pegasus Optimization Systems will arbitrate among the solutions for the above systems.

a. Goals for the past quarter were:
   i. Complete remote access via VPN to the site.
   ii. Draft the functional specifications for the VOAs
   iii. Research points for the PERFIndex.
   iv. Configure the PERFIndex and load to site.
   v. Gather preliminary information on the simulator interface.
   vi. Make efficiency improvements in the configuration of alternative scenario evaluations
   vii. Make efficiency improvements in the configuration of discrete event evaluation (e.g. soot blowing operations)
b. Accomplishments for the past quarter were:
   i. The VPN connection has been in use with no availability issues.
   ii. The functional specification for the VOAs was not completed due to personnel assignments on other areas.

iii. The points for the PERFIndex were completed.
iv. The Configuration of the PERFIndex is in process.
v. Efficiency improvements were made in the software for both alternative scenario evaluations and discrete event evaluation. In the subsequent period, both of these capabilities will be tested extensively for use in both combustion optimization and soot blowing optimization.

4 Cost Status

This fourth period report EVA is identical to the monthly EVA finished at Feb 28, 2007. This is different from the end of the quarter due to the "no cost extension" which is in process and will be using February 28th, 2007 as the date for the reforecast adjustment. Hence that data is reported here and is consistent with the information provided in the DOE meeting in Pittsburgh on April 4, 2007.

A proportion of the initial spending was done at risk to Pegasus under the terms of the pre-award agreement. This initial funding was used in large part to procure the initial subvendor contracts in order to make best as possible use of the unit outage at Limestone. Much of the critical work was accomplished and as of this date no schedule adjustment from originally proposed dates are noted. Some future adjustment to schedule may need to be taken which would accommodate delays in the CA approval process; however none are anticipated as this report. Pegasus remains working to achieve the draft schedule submitted in 2005 prior to the issuance and final approvals of the CA

Total approved budget for Phase I	$9,156,712
DOE Share of Total Approved Budget	$3,577,451
Pegasus/NeuCo Share of Budget	$5,579,261

Table 1: Project Spending per form 270 Feb 2007

	This Period	Project to Date
Expenses	$ 105,527.51	$2,585,018.06
G&A Expense	$ 79,145.63	1,491,331.95
Total Quarterly Expense	$ 184,673.14	4,076,350.02
Billable Percentage	0.390692	0.390692
Quarterly DOE Billable Amount	$ 72,150.32	$1,592,597.34
Quarterly Pegasus Non-Bill Amount	$ 112,522.82	$2,483,752.68
DOE Billable	$72,150.32	$1,592,597.341
DOE Billed	$ 37,645.88	$1,536,778.65
DOE Unbilled	$ 55,818.69	$55,818.69079

5 Schedule Status

The progress to schedule is behind original schedule; however it is important to point out that this had remained the original schedule as submitted in the proposal which had anticipated CA approval and award at the turn of the year rather than April of 2006. The needed opportunity outage did not occur until March 07. This delay has resulted in a net 5 month delay of BP1, for which we have submitted a "no cost extension".. A letter of discussion and has been sent to the DOE contact and presented at the April 4, 2007 meeting with DOE in Pittsburgh.

6 Reportable changes or problems for the period

No changes to report during this period other than the aforementioned delay with subvendor installation time.

7 Absence or changes of key personnel

No changes to report during this period.

8 Product Completed/Produced, Technology Transferred, Presentations, Patents

9 Conclusion

The project has moved forward on accomplishing the primary area of focus which is the installation of advanced sensors. All of these devices have had their base equipment installed and are in various stages of configuration, calibration, or verification. There have been some disruptions and delays to schedule as discussed. We do not consider any of the delays related to technical concept barriers.

9.1 Intelligent Fuel Management System (FMS)

Pegasus/NeuCo and site are continuing technical work with Ready Engineering Coal Fusion System. The SABIA's elemental analyzer for this task is operational and coal samples are completed and in the run in period.

9.2 Mercury Specie Control System:

All equipment in this section has been physically located and is in various stages of completion for tuning and calibrations. The Zolo Laser Spectroscopy Analyzer sensors needed an opportunity outage for installation while the Triple 5 coal flow sensors are being completed easily and ahead of planned effort. The Mercury CEMS have had heater problems, which were resolved, and can now continue forward but remain something to monitor for risk. This is one of the most significant measurements in the project and as such is being monitored by all involved.

9.3 Advanced Electrostatic Precipitator (ESP) Optimization

Pegasus/NeuCo has installed equipment to interface serially to the TR sets of the ESP. This data exchange will enable the most completed set of data to be captured. This equipment has already been connected at site. The data and I/O matrix of the functional specification for the ESP was completed, and approved with site.

9.4 System Advanced Intelligent Soot Blowing (ISB) System:

Pegasus/NeuCo and Limestone's systems engineers have completed the method for interface to the existing sootblowing system and have established the required I/O list for this section.

9.5 Advanced Flue Gas Desulfurization (FGD) Optimization System:

Pegasus/NeuCo submitted the functional specification for the FGD is reviewed..

9.6 Intelligent Optimization:

Simulation discussions are on-going with site as reported in the April 4 meeting.

9.7 Project management

Project management required activities were completed during the period.

10 References

None to state for this report

11 List of Acronyms and Abbreviations

(Consolidated list as may be used in this or future reference reports)

API	Application Programming Interface
BTU	British Thermal Unit
CCPI	Clean Coal Power Initiative
CEMS	Continuous Emissions Monitoring System
CO	Carbon Monoxide
CO2	Carbon Dioxide
DCS	Distributed Control System
DOE	Department of Energy
FEGT	Furnace Exit Gas Temperature
ESP	Electro Static Precipitator
FD	Forced Draft
FGD	Flue Gas Draft
FT^3	Cubic Feet
GUI	Graphical User Interface
HMI	Human Machine Interface
HR	Heat Rate
H_2O	Water
ID	Induced Draft
ISB	Intelligent Sootblowing
LAN	Local Area Network
LOI	Loss on Ignition
Mol Wt	Molecular Weight
mmBTU	Millions of BTUs
mm	Million
MW	Megawatt
mWh	Megawatt hour
M/year	Million per year
N_2	Nitrogen

NH_3	Ammonia
NOx	Nitrogen Oxides
O_2	Oxygen
OEM	Original Equipment Manufacturer
OFA	Over Fire Air
OPC	OLE for Process Control
PC	Personal Computer
PLC	Programmable Logic Controller
ppm	parts-per-million
PRB	Powder River Basin
PTC	Power Test Code
RH	Re heater
S	Sulfur
SA	Secondary Air
SH	Super Heater
SO2	Sulfur Dioxide
SO3	Sulfur Trioxide
TC	Thermocouple
VPN	Virtual Private Network
V&V	Verification and Validation